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(54) **COMBUSTION TURBINE COOLING PANEL**

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PLAQUE DE REFROIDISSEMENT POUR TURBINE A GAZ

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Description

Field of the Invention

[0001] The present invention relates generally to combustion turbines and more particularly to an apparatus for cooling combustor turbine components.

Background of the Invention

[0002] Combustion turbines comprise a casing for housing a compressor section, combustor section and turbine section. Each one of these sections comprise an inlet end and an outlet end. A combustor transition member is mechanically coupled between the combustor section outlet end and the turbine section inlet end to direct a working gas from the combustor section into the turbine section. Conventional combustor transition members may be of the solid wall type or interior cooling channel wall type (see Figure 1). In either design, the combustor transition member is formed from a plurality of metal panels.

[0003] The working gas is produced by combusting an air/fuel mixture. A supply of compressed air, originating from the compressor section, is mixed with a fuel supply to create a combustible air/fuel mixture. The air/fuel mixture is combusted in the combustor to produce the high temperature and high pressure working gas. The working gas is ejected into the combustor transition member to change the working gas flow exiting the combustor from a generally cylindrical flow to an generally annular flow which is, in turn, directed into the first stage of the turbine section.

[0004] As those skilled in the art are aware, the maximum power output of a gas turbine is achieved by heating the gas flowing through the combustion section to as high a temperature as is feasible. The hot working gas, however, may produce combustor section and turbine section component metal temperatures that exceed the maximum operating rating of the alloys from which the combustor section and turbine section are made and, in turn, induce premature stress and cracking along various turbomachinary components, such as a combustor transition member.

[0005] Several prior art apparatus have been developed to cool combustor transition members. Examples of such prior art devices are shown in U.S.-A-3,349,558 and Soviet Inventions Illustrated, Derwent Publications, Ltd., London, GB; AN XP002081602 & SU-A-170 786 (Abstract). Some of these apparatus include impingement plates, baffles, and cooling sleeves spaced about the combustor transition member outer surface. These apparatus, however, have several drawbacks.

[0006] One drawback with these prior art cooling apparatus is that each type of cooling apparatus can only be employed with a specific transition member. If one owns combustion turbines that require various types of transition members, then an inventory of various types of cooling apparatus are required for maintenance purposes. It would, therefore, be desirable to provide a cooling apparatus that can be employed with more than one type of transition member.

[0007] Other conventional methods have been developed to overcome the need for separate apparatus for cooling a transition. Figure 1, which shows one of these methods, is a transition member 20 having a sidewall 22 that defines an interior working gas flow channel 24. The interior working gas flow channel has an inlet end 26 and exit end 28. The sidewall 22 comprises a plurality of interior cooling flow channels 30, cooling air entrance holes 32 and cooling air exit holes 35. The transition member 20 is cooled by a cooling fluid that enters the cooling air entrance holes 32, travels through the interior cooling flow channels 30, exits past the exit holes 35, and, in turn, enters into the working gas flow channel 24.

[0008] The transition member 20 is manufactured from a plurality of panels 34 that define the interior cooling flow channels 30 and cooling air exit holes 35, as shown in Figure 2. The panels 34 are made from a first metal plate 36 and second metal plate 38. The interior cooling flow channels 30 are formed by attaching the first metal plate 36 and second metal plate 38 together. The first metal plate 36 is formed with a plurality of grooves 40 that extend along a relative longitudinal direction for substantially the entire length of the first plate 36. The exit holes 35 are formed in the first plate 36 in fluid communication with at least one groove 40. The second plate 38 is formed with the cooling flow entrance holes 32 which are in fluid communication with the grooves 40. After attaching the first 36 and second panels 38 together, a plurality of cooling panels are formed into the desired shape to form a particular transition member. Transition members 20 made from these panels 34, however, have several drawbacks.

[0009] One drawback of employing this type of transition member 20 is that they commonly fail at a relatively small area along the interior cooling flow channel 30. The area that fails cannot be repaired or replaced and, therefore, the entire transition member 20 must be replaced. The replacement of an entire transition member 20 is relatively costly. It would, therefore, be desirable to provide a transition member that allows for the replacement of less than the entire transition member after the transition member has suffered less than an entire failure.

SUMMARY OF THE INVENTION

[0010] A cooling panel for cooling a turbine member is provided. The cooling panel comprises a first panel having a relative width, length, upper surface and lower surface. The upper surface defines at least one corrugated portion traversing along a portion of the relative width of the upper surface. The corrugated portion defines a cooling flow channel through which a cooling fluid can travel to cool the turbine member. The cooling flow

channel has at least one inlet opening for enabling the cooling fluid to enter into the cooling flow channel. The first panel is adapted to be coupled in fluid communication with the working fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 is a partial cut-out view of a prior art transition member;
Figure 2 is a partial cut-out view of a cooling panel employed to manufacture the transition member shown in Figure 1;
Figure 3 is a sectional-view of a combustion turbine in accordance with the present invention;
Figure 4 is an enlarged view of a section of the compressor, combustor, transition member, cooling panel and turbine shown in Figure 3;
Figure 5 is a partial cut-out view of the transition member and cooling panel shown in Figure 4;
Figure 6 is a perspective view of the cooling panel shown in Figure 5;
Figure 7 is a frontal view of the cooling panel shown in Figure 6;
Figure 8 is a partial cut-out planar view of the cooling panel shown in Figure 6;
Figure 9 is a partial cut-out view of a transition member according to another aspect of the invention;
Figure 10 is a perspective view of a cooling panel and metal panel employed to manufacture the transition member shown in Figure 9;
Figure 11 is a partial cut-out planar view of the cooling panel shown in Figure 10;
Figure 12 is a frontal view of the cooling panel and metal panel shown in Figure 10; and
Figure 13 is a sectional view taken along section line 13-13 in Figure 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Referring to the drawings, wherein like reference numerals designate corresponding structure throughout the views, and in particular to Figure 3, a gas turbine 50 of the type employing the present invention is shown. The gas turbine 50 comprises a combustor shell 48, compressor section 52, combustor section 54, and a turbine section 56.

[0013] Referring to Figure 4, the air compressor 52, combustor 54, and a portion of the combustor shell 48 and turbine 56 are shown. Additionally, a conventional solid wall type transition member 58 is coupled at its inlet end 60 to the combustor 54, and at its exit end 62 to the first stage of the turbine 56.

[0014] In accordance with one aspect of the present invention, a cooling panel 64 is provided to cool a portion of the transition member 58. The conventional transition member 58 is adapted or retrofitted to be mechanically coupled with the cooling panel 64. The preferred modifications made to the conventional transition member 58 are discussed in more detail below. It is noted that although the following description refers to the application of the cooling panel 64 to a solid wall type transition member 58, the cooling panel 64 may be employed to cool other types of transition members and turbine members if these types of apparatus are changed to comprise a solid panel.

[0015] Referring to Figure 5, the transition member 58 and cooling panel 64 are shown in more detail. The transition member 58 comprises a sidewall 66 having an interior surface 68 and exterior surface 70. The interior surface 68 defines a working gas flow channel 72. The working gas flow channel 72 extends from the inlet opening 60 to the exit opening 62. The transition member 58 is retrofitted with cooling flow inlet holes 90. Each inlet hole 90 extends to the interior surface 68 of the transition member 58 such that each cooling panel 64 is in fluid communication with the working gas flow channel 72. The cooling flow inlet holes 90 are discussed in more detail below.

[0016] The cooling panel 64 has a relative outer surface 74 and relative inner surface 76. The relative inner surface 76 of the cooling panel 64 is mechanically coupled adjacent to a lower portion 78 of the exterior surface 70 of the transition member 58 proximate to the transition member exit opening 62. In this arrangement, the exterior surface 70 of the transition member 58 and cooling panel 64 are exposed to the relatively cool air discharged from the compressor section 52 and directed by the combustor shell 48. It is noted that the number and placement of the cooling panels 64 may vary depending on the desired cooling requirements of a particular transition member, as will be understood by those familiar with such particular transition members. A more detailed discussion of how the transition member 58 and cooling panel 64 are coupled is provided below.

[0017] Figure 6 shows the cooling panel 64 in more detail. The cooling panel 64 is made from a first metal panel 65 that has a relative length L and relative width W. These dimensions may vary from cooling panel to cooling panel 64 depending on what type of transition member or portion of a transition member that may be cooled. Preferably, each cooling panel 64 defines a plurality of corrugations 80 that traverse the entire width W of the cooling panel 64. Each corrugation 80 defines a cooling flow channel 82 along the relative inner surface 76 of the cooling panel 64. It is noted that a cooling panel 64 can define a single corrugation 80 with a cooling flow channel 82. In this case, one or a series of cooling panels having a single cooling flow channel 82 may be aligned to perform the same functions as a cooling panel having a plurality of cooling flow channels.

[0018] Preferably, each cooling flow channel 82 has an open end 84 and an opposing closed end 86. This arrangement alternates from one cooling flow channel

82 to the next adjacent cooling flow channel 82. The open end 84 is adapted to direct the cooling fluid from combustor shell 48 into the cooling flow channel 82. The closed end 86 is formed during the forming of the panel 64. A stamping method may be employed to form each cooling panel 64 with corrugations 80. Types of material that are employed to manufacture cooling panels 64 include Hastelloy X, IN-617, and Haynes 230.

[0019] Referring to Figure 7, the cooling panel 64 is shown coupled adjacent to the lower portion 78 of the exterior surface 70 of the transition member 58 proximate the transition member exit opening 62. The transition member 58 is retrofitted so the cooling panel 64 can be employed to cool a portion of the transition member 58. To retrofit the transition member 58, a plurality of cooling flow exit holes 90 are formed through the lower portion 78 of the transition member 58 at relative locations where corresponding cooling flow channels 82 will be aligned once the cooling panel 64 is coupled with the transition member 58.

[0020] Preferably, only one cooling flow exit hole 90 is provided in the transition member 58 per each cooling flow channel 82 at relative locations proximate to the closed end 86 of the cooling flow channel 82. As shown, five cooling flow channels 82 are formed in the cooling panel 64, therefore, five cooling flow exit holes 90 are formed in the transition member 58 at relative locations proximate to the closed end 86 of each cooling flow channel 82. It is noted that multiple cooling flow exit holes 90 can be provided in the transition member for each cooling flow channel 82.

[0021] Preferably, the periphery of each cooling panel 64 is fillet welded to the lower portion 78 of the exterior surface 70 of the transition member 58. Additionally, the attaching surface 77 of the cooling panel 64 may be spot welded 92 to the transition member 58. Additionally, the attaching surface 77 that extends between the full length of each cooling flow channel 82 is welded to the transition member to provide a seal between each cooling flow channel 82 to prevent cooling air from leaking into adjacent cooling flow channels 82. Methods or techniques of providing this seal include tig welding and laser welding.

[0022] Referring to Figure 8, preferably, all of the corrugations 80 that are formed on a single cooling panel 64 have substantially the same geometric shape and same dimensions, and are spaced equidistantly apart from each neighboring corrugation 80. Preferably, each corrugation 80 comprises a relative height H with a peak radius R_P, two leg radii R_L, and a longitudinal axis L. The peak radius R_P blends smoothly with each one of the leg radii R_L. Each leg radii R_L extends into and blends smoothly with a corresponding attaching surface 77. It is noted that the corrugation 80 may be of other geometric shapes and sizes and in various combinations of shapes and sizes depending upon the desired cooling requirements. The relative bottom of each attaching surface 77 is adapted to be mechanically coupled with the transition member 58.

[0023] The preferred dimensions of each one of the corrugations 80 are listed below. The relative height H of each corrugation 80 is approximately 0.150 inches. Each peak radius R_P is approximately 0.050 inches. Each leg radii R_L is approximately 0.10 inches. The attaching surface 77 extends between each corrugation 80 for approximately 0.200 inches. The distance between each neighboring longitudinal axis is approximately 0.500 inches.

[0024] As an improvement over the prior art transition member shown in Figure 1, a single cooling panel 64 that has suffered either a partial or full failure can be replaced without having to replace the entire transition member 58. Each cooling panel 64 is adapted to be removed by any known method and replaced with another cooling panel 64. Such removing methods include grinding or filing down all of the corrugated surfaces 80 formed on a particular cooling panel 64 until the transition member 58 exterior surface 70 is reached. Upon reaching the exterior surface 70, another cooling panel 64 is coupled to that area of the transition member 58 by the methods discussed above.

[0025] The cooling panel 64 may also be employed to cool other types of transition members after the transition members have been retrofitted in the same or similar manner as the solid wall transition member. The size and number of cooling panels that are required to adequately cool these conventional transition members may vary with transition member design. Additionally, the cooling panel 64 may be coupled at different locations to cool various parts of a transition member.

[0026] The cooling panel 64 in accordance with the present invention will be described in operation with a solid wall type transition member 58. The exterior surface 68 of the transition member 58 is convectively cooled by compressed air in the combustor shell 48 flowing from the compressor section 52 toward the combustor 54. A portion of the exterior surface 70 of the transition member 58 is disposed in the direct flow of the compressed air as it changes direction after exiting the compressor section 52. The lower portion 78 of the exterior surface 70 proximate to the turbine section 56 is coupled with the cooling panel 64. The cooling panel 64 is coupled to the transition member 58 such that the cooling flow channels 82 are in fluid communication with the cooling flow exit holes 90 formed in the transition member 58 and combustor shell air 48. The compressed air exiting the compressor section 52 enters the open end 84 of the cooling panel flow channel 82 and travels through the cooling flow channels 82 while removing heat from the transition member 58. The air then travels through the cooling flow exit hole 90 formed in the transition member 58 until reaching the working gas flow channel 72. The air is then mixed in with the working gas and directed into the turbine section 56.

[0027] Referring to Figure 9, an improved transition member 100 in accordance with another aspect of the

present invention is provided. The transition member 100 comprises a sidewall 102 having an interior surface 104 and exterior surface 106. The interior surface 104 defines an interior working gas flow channel 108 having an inlet opening 110 and exit opening 112. The inlet opening 110 is adapted to be mechanically coupled with a combustor 54, and the exit opening 112 is adapted to be coupled to the first stage of a turbine 56.

[0028] The exterior surface 106 of the sidewall 102 defines a plurality of cooling flow channels 114 that are in fluid communication with the working gas flow channel 108. The cooling channels 114 are provided at locations proximate to those areas of the transition member 100 that may be cooled during the operation of the combustion turbine.

[0029] A plurality of cooling flow inlet holes 120 are formed through the sidewall 102 at relative locations where corresponding cooling flow channels 114 are aligned. Each inlet hole 120 extends to the interior surface 104 of the transition member 100 such that the cooling flow channels 114 are in fluid communication with the transition member working gas flow channel 108 and combustor shell air 48.

[0030] The sidewall 102 is made up of a plurality of metal panels 124 and cooling panels 126, as shown in Figure 10. The metal panels 124 and cooling panels 126 are coupled together such that they form the desired transition member 100. Conventional methods of coupling metal panels to form conventional transition members may be employed to coupled the metal panels 124 and cooling panels 126 to form the transition member 100.

[0031] After all of the metal panels 124 and cooling panels 126 have been coupled, all of the metal panels 124 and cooling panels 126 define the working gas flow channel 108. The placement of each metal panel 124 and cooling panel 126 to form the transition 100 may vary depending on what size transition member is desired and the area of the transition member that may be cooled. The metal panel 124 can be manufactured from materials and methods employed for forming conventional transition members. Such materials include IN-617, Haynes 230, and Hastelloy X. One method of forming the transition member includes stamping methods.

[0032] Preferably, each one of the cooling panels 126 has a plurality of corrugations 136 that traverse along the relative width W of an outer metal sheet 134 to form each cooling flow channel 114. Preferably, all of the corrugations 136 that are formed on a single outer metal sheet 134 have substantially the same geometric shape and same dimensions as the corrugations 80 discussed above. Each cooling flow channel 114 has an open end 116 and an opposing closed end 118. This arrangement alternates from one cooling flow channel 114 to the next cooling flow channel 114. The open end 116 is adapted to direct the cooling fluid from the combustor shell 48 into the cooling flow channel 114.

[0033] Referring to Figure 11, preferably, only one cooling flow exit hole 120 is provided per each cooling flow channel 114 at a relative location proximate to the closed end 118 of the cooling flow channel 114.

[0034] Referring to Figures 12 and 13, preferably, each one of the cooling panels 126 is made of a relative inner metal sheet 132 and relative outer metal sheet 134. The relative inner metal sheet 132 becomes the interior surface 104 of the completed transition member 100 after the metal panels 124 and cooling panels 126 are coupled. The relative inner metal sheet 132 also defines the cooling fluid exit holes 120. Methods of coupling these sheets 132 and 134 are well known in the art. One method includes the welding techniques discussed above.

[0035] It is to be understood that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

Claims

1. A cooling panel (64) for cooling a turbine member 58, said cooling panel (64) comprising:

   a first panel (65) having a relative width (W), Length (L), outer surface (74) defining a plurality of corrugated portions (80) traversing along a portion of the relative width of said outer surface, said corrugated portion (80) defining a cooling flow channel (82) through which a cooling fluid can travel to cool the turbine member (58), said cooling flow channel (82) having at least one inlet opening (84) for enabling the cooling fluid to enter into the cooling flow channel, said inner surface (76) adapted to be coupled with the turbine member (58); and
   said cooling panel (64) **characterized in that** said corrugation (80) further comprise a closed end (86) opposing said inlet opening.

2. The cooling panel (64) in claim 1, **characterized in that** said first panel (65) is adapted to be coupled to the turbine member and enable a portion (80) of the cooling panel (64) to be removed and replaced with another cooling panel.

3. The cooling panel (64) in claim 1, **characterized in that** the positioning of the inlet opening (84) and closed end (86) of one corrugation (80) are located at opposite ends relative to adjacent corrugations.

4. The cooling panel (64) in claim 1, **characterized in that** each corrugation (80) comprises a relative peak radius (R_P) and two leg radii (R_L), said peak radius (R_P) blending substantially smoothly with each one of said leg radii (R_L).

5. The cooling panel (64) in claim 1, **characterized in that** each corrugation (80) is spaced equidistant apart from each neighboring corrugation.

6. The cooling panel (64) in claim 4, **characterized in that** each leg radii (R_L) extends into and blends generally smoothly with corresponding generally flat surface, said generally flat surface having an upper portion and bottom portion (77), said bottom portion (77) of each generally flat surface adapted to be removably coupled with the turbine member.

7. An improved combustor transition member (100) comprising:

   a side wall (102) having an exterior surface (100) and interior surface (104), said interior surface (104) defining a working gas flow channel (108) having an inlet end (110) and outlet end (112);
   at least one cooling panel (126), said cooling panel (126) comprising at least one corrugation (136) protrudes in a outwardly direction relative to said exterior surface (100) of said side wall (102) which defines a cooling flow channel (114), said cooling panel (126) mechanically coupled with said side wall (102), and wherein said side wall (102) further defines at least one cooling flow exit hole in fluid communication with the working gas flow channel (108) and said cooling flow channel (114), such that said cooling flow channel (114) is in fluid communication with said working gas flow channel(108); and
   such transition member **characterized in that** said corrugation (136) has a closed end and opposing open end.

8. The transition member ion Claim 7, **characterized in that** at least a portion of the cooling panel (126) is adapted to be replaced with a portion of another cooling panel (126).

Patentansprüche

1. Kühltafel (64) zum Kühlen eines Turbinenelements (58), wobei die Kühltafel (64) folgendes umfaßt:

   eine erste Tafel (65) mit einer relativen Breite (W), einer Länge (L), einer Außenfläche (74), die mehrere gewellte Bereiche (80) definiert, die quer an einem Bereich der relativen Breite der Außenfläche entlang verlaufen, wobei der gewellte Bereich (80) einen Kühlströmungskanal (82) definiert, durch den ein Kühlfluid strömen kann, um das Turbinenelement (58) zu kühlen, wobei der Kühlströmungskanal (82) mindestens eine Einlaßöffnung (84) besitzt, damit das Kühlfluid in den Kühlströmungskanal eintreten kann, wobei die Innenfläche (76) so ausgeführt ist, daß sie mit dem Turbinenelement (58) verbunden werden kann; und
   die Kühltafel (64) **dadurch gekennzeichnet ist, daß** die Wellung (80) weiterhin ein geschlossenes Ende (86) gegenüber der Einlaßöffnung umfaßt.

2. Kühltafel (64) nach Anspruch 1, **dadurch gekennzeichnet, daß** die erste Tafel (65) so ausgeführt ist, daß sie mit dem Turbinenelement verbunden und ein Bereich (80) der Kühltafel (64) entfernt und durch eine andere Kühltafel ersetzt werden kann.

3. Kühltafel (64) nach Anspruch 1, **dadurch gekennzeichnet, daß** die Positionierung der Einlaßöffnung (84) und des geschlossenen Endes (86) einer Wellung (80) an im Verhältnis zu benachbarten Wellungen gegenüberliegenden Enden erfolgt.

4. Kühltafel (64) nach Anspruch 1, **dadurch gekennzeichnet, daß** jede Wellung (80) einen relativen Spitzenradius (R_P) und zwei Schenkelradien (R_L) umfaßt, wobei der Spitzenradius (R_P) im wesentlichen gleitend in jeden der Schenkelradien (R_L) übergeht.

5. Kühltafel (64) nach Anspruch 1, **dadurch gekennzeichnet, daß** jede Wellung (80) im gleichen Abstand zu jeder benachbarten Wellung angeordnet ist.

6. Kühltafel (64) nach Anspruch 4, **dadurch gekennzeichnet, daß** jeder der Schenkelradien (R_L) sich in eine entsprechende, allgemein flache Oberfläche hineinerstreckt und im allgemeinen gleitend in sie übergeht, wobei die im allgemeinen flache Oberfläche einen oberen Bereich und einen Bodenbereich (77) aufweist, wobei der Bodenbereich (77) jeder im allgemeinen flachen Oberfläche so ausgeführt ist, daß er entfernbar mit dem Turbinenelement verbunden werden kann.

7. Verbessertes Brennerübergangselement (100), umfassend:

   eine Seitenwand (102) mit einer Außenfläche (100) und. einer Innenfläche (104), wobei die Innenfläche (104) einen Arbeitsgasströmungskanal (108) mit einem Einlaßende (110) und ei-

nem Auslaßende (112) definiert;
mindestens eine Kühltafel (126), die mindestens eine Wellung (136) umfaßt und in einer nach außen verlaufenden Richtung im Verhältnis zur Außenfläche (100) der einen Kühlströmungskanal (114) definierenden Seitenwand (102) herausragt, wobei die Kühltafel (126) mit der Seitenwand (102) mechanisch verbunden ist und die Seitenwand (102) weiterhin mindestens ein Kühlströmungsaustrittsloch definiert, das in Fluidverbindung mit dem Arbeitsgasströmungskanal (108) und dem Kühlströmungskanal (114) steht, so daß der Kühlströmungskanal (114) in Fluidverbindung mit dem Arbeitsgasströmungskanal (108) steht; und
ein Übergangselement, das dadurch gekennzeichnet ist, daß die Wellung (136) ein geschlossenes Ende und ein gegenüberliegendes offenes Ende besitzt.

8. Übergangselement nach Anspruch 7, **dadurch gekennzeichnet, daß** mindestens ein Bereich der Kühltafel (126) so ausgeführt ist, daß er durch einen Bereich einer anderen Kühltafel (126) ersetzt werden kann.

Revendications

1. Panneau de refroidissement (64) pour refroidir un élément de turbine (58), ledit panneau de refroidissement (64) comprenant :

   un premier panneau (65) ayant relativement une largeur (W), une longueur (L), une surface extérieure (74) définissant une pluralité de parties ondulées (80) s'étendant en travers le long d'une partie de la largeur de la surface extérieure, la partie ondulée (80) définissant un canal de courant de refroidissement (82) dans lequel un fluide de refroidissement peut passer pour refroidir l'élément de turbine (58), le canal de courant de refroidissement (82) comportant au moins une ouverture d'entrée (84) pour permettre au fluide de refroidissement de pénétrer dans le canal de courant de refroidissement, la surface intérieure (76) étant conçue pour être couplée à l'élément de turbine (58); et
   le panneau de refroidissement (64) étant **caractérisé en ce que** l'ondulation (80) comprend également une extrémité fermée (86) à l'opposé de l'ouverture d'entrée.

2. Panneau de refroidissement (64) selon la revendication 1, **caractérisé en ce que** le premier panneau (65) est conçu pour être couplé à l'élément de turbine et pour permettre à une partie (80) du panneau de refroidissement (64) d'être enlevée et remplacée par un autre panneau de refroidissement.

3. Panneau de refroidissement (64) selon la revendication 1, **caractérisé en ce que** l'ouverture d'entrée (84) et l'extrémité fermée (86) d'une ondulation (80) sont situées à des extrémités opposées relativement à des ondulations adjacentes.

4. Panneau de refroidissement (64) selon la revendication 1, **caractérisé en ce que** chaque ondulation (80) comprend un rayon maximal relatif (R_p) et deux rayons de côté (R_L), le rayon maximal (R_p) fusionnant sensiblement en douceur avec chacun des rayons de côté (R_L).

5. Panneau de refroidissement (64) selon la revendication 1, **caractérisé en ce que** chaque ondulation (80) est située à égale distance de chaque ondulation voisine.

6. Panneau de refroidissement (64) selon la revendication 4, **caractérisé en ce que** chaque rayon de côté (R_L) s'étend dans, et fusionne généralement en douceur avec, une surface généralement plate correspondante, la surface généralement plate comportant une partie supérieure et une partie inférieure (77), la partie inférieure (77) de chaque surface généralement plate étant conçue pour être couplée, de manière amovible, avec l'élément de turbine.

7. Elément intermédiaire perfectionné de chambre de combustion (100) comprenant :

   une paroi latérale (102) comportant une surface extérieure (106) et une surface intérieure (104), la surface intérieure (104) définissant un canal de courant de gaz de travail (108) comportant une extrémité d'entrée (110) et une extrémité de sortie (112) ;
   au moins un panneau de refroidissement (126), le panneau de refroidissement (126) comprenant au moins une ondulation (136) faisant saillie dans une direction vers l'extérieur relativement à la surface extérieure (106) de la paroi latérale (102) qui définit un canal de courant de refroidissement (114), le panneau de refroidissement (126) étant couplé mécaniquement à la paroi latérale (102), et dans lequel la paroi latérale (102) définit en outre au moins un orifice de sortie de courant de refroidissement en communication de fluide avec le canal de courant de gaz de travail (108) et le canal de courant de refroidissement (114), de manière que le canal de courant de refroidissement (114) soit en communication de fluide avec le canal de courant de gaz de travail (108) ; et
   un tel élément intermédiaire étant **caractérisé**

en ce que l'ondulation (136) a une extrémité fermée et une extrémité ouverte opposée.

8. Elément intermédiaire selon la revendication 7, **caractérisé en ce qu'**au moins une partie du panneau de refroidissement (126) est conçue pour être remplacée par une partie d'un autre panneau de refroidissement (126).

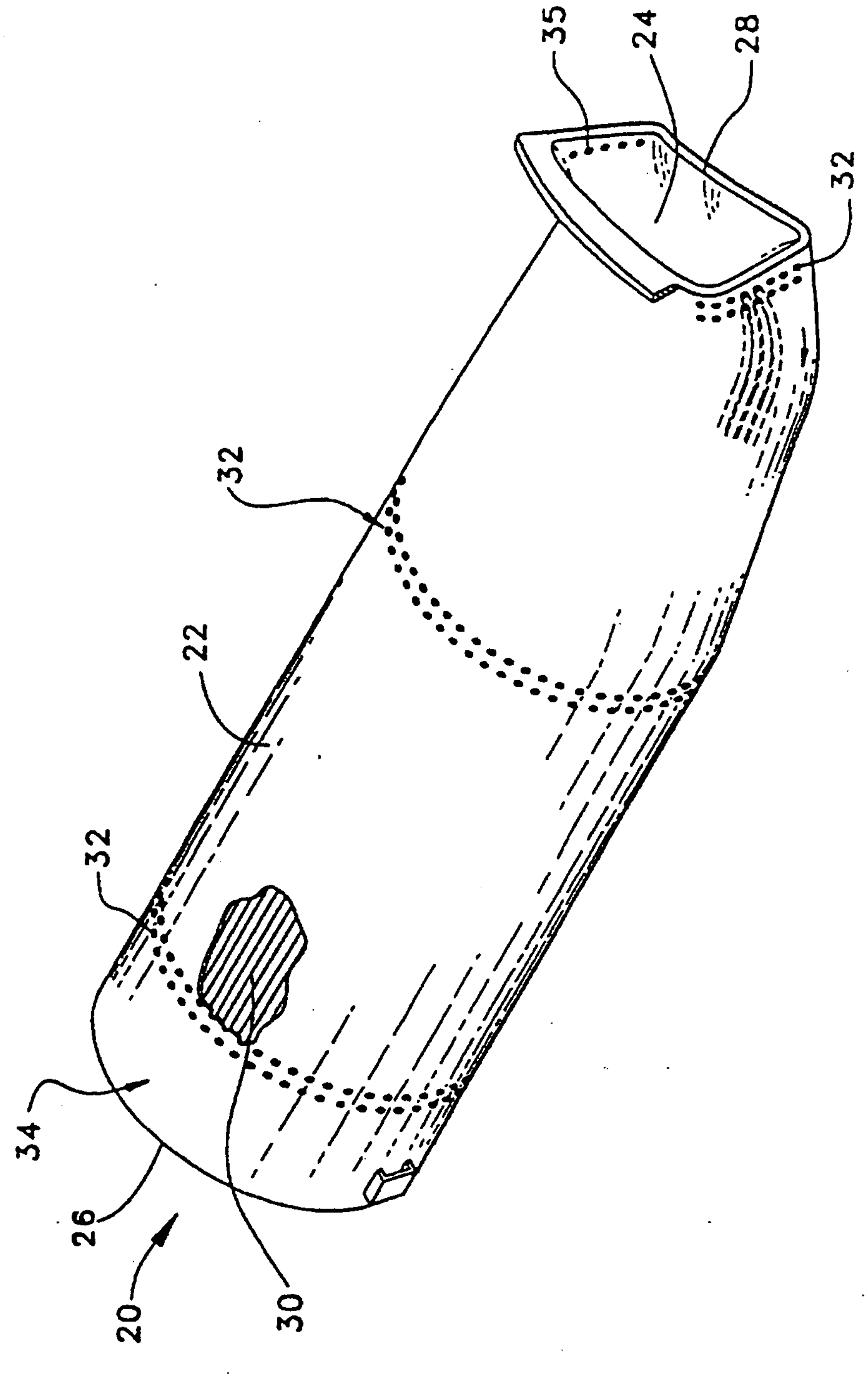

FIG. 1
(PRIOR ART)

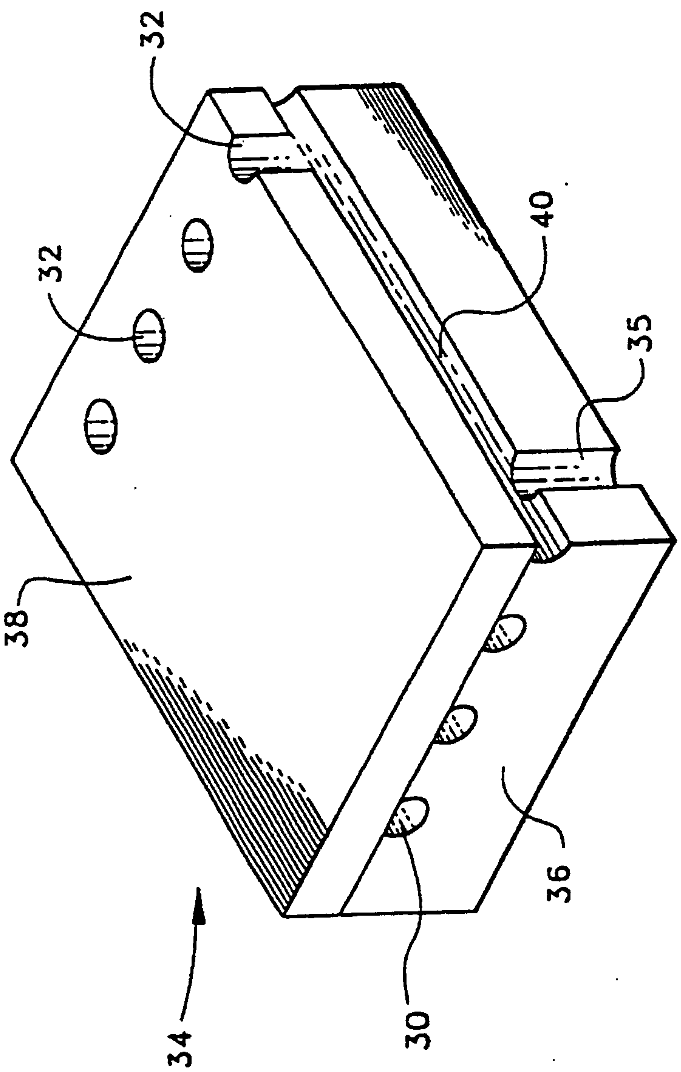

FIG. 2
(PRIOR ART)

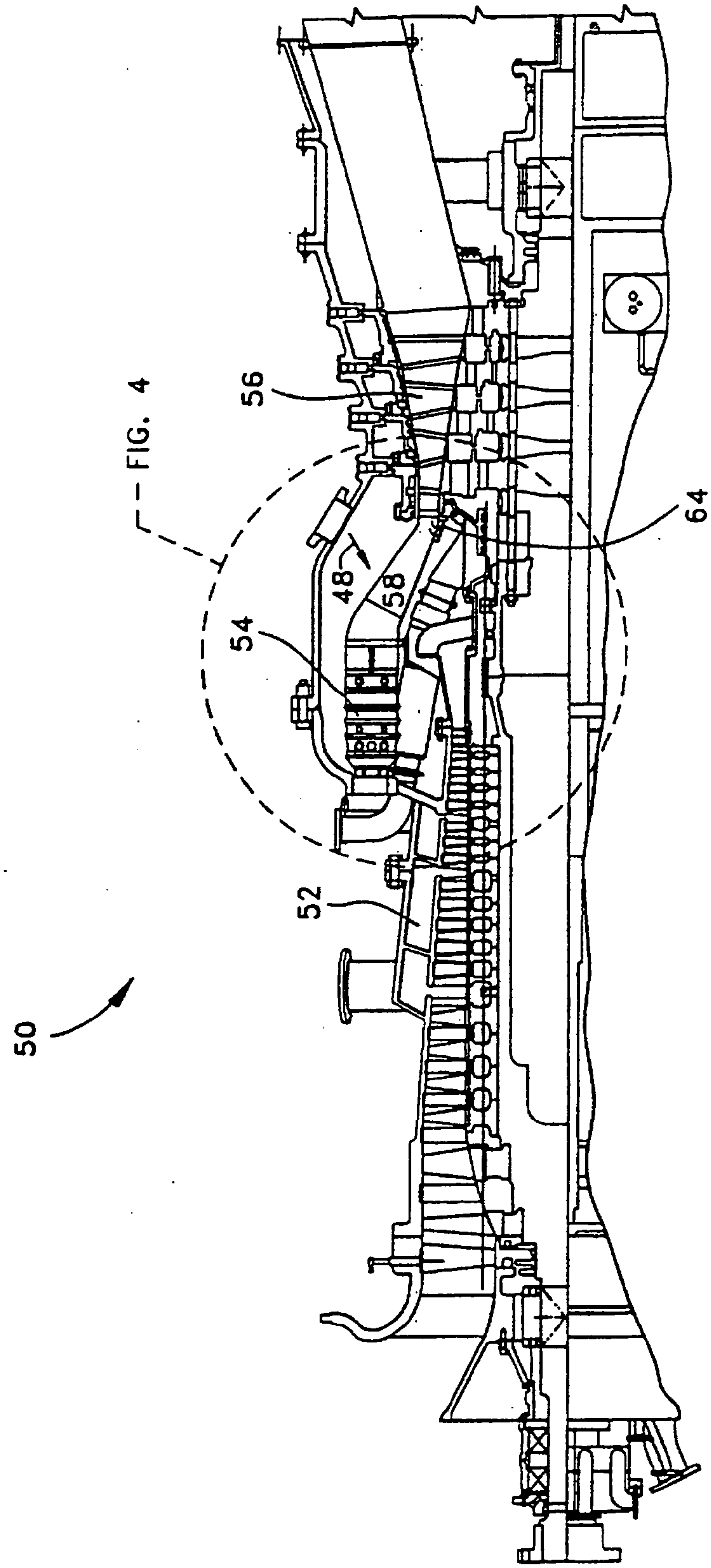

FIG. 3

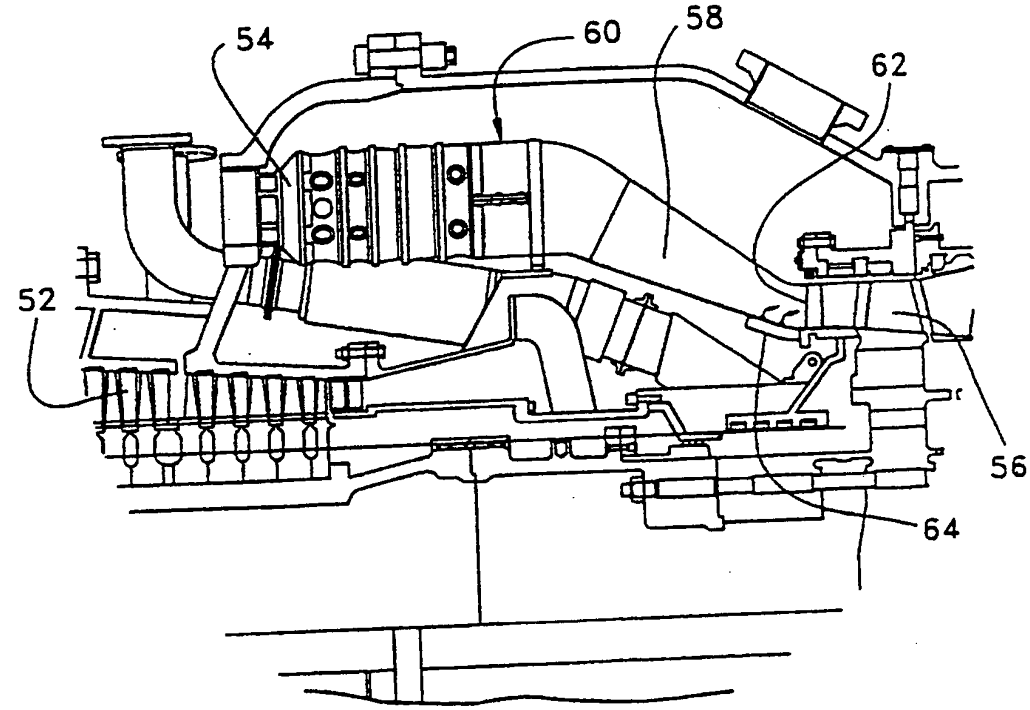

FIG. 4

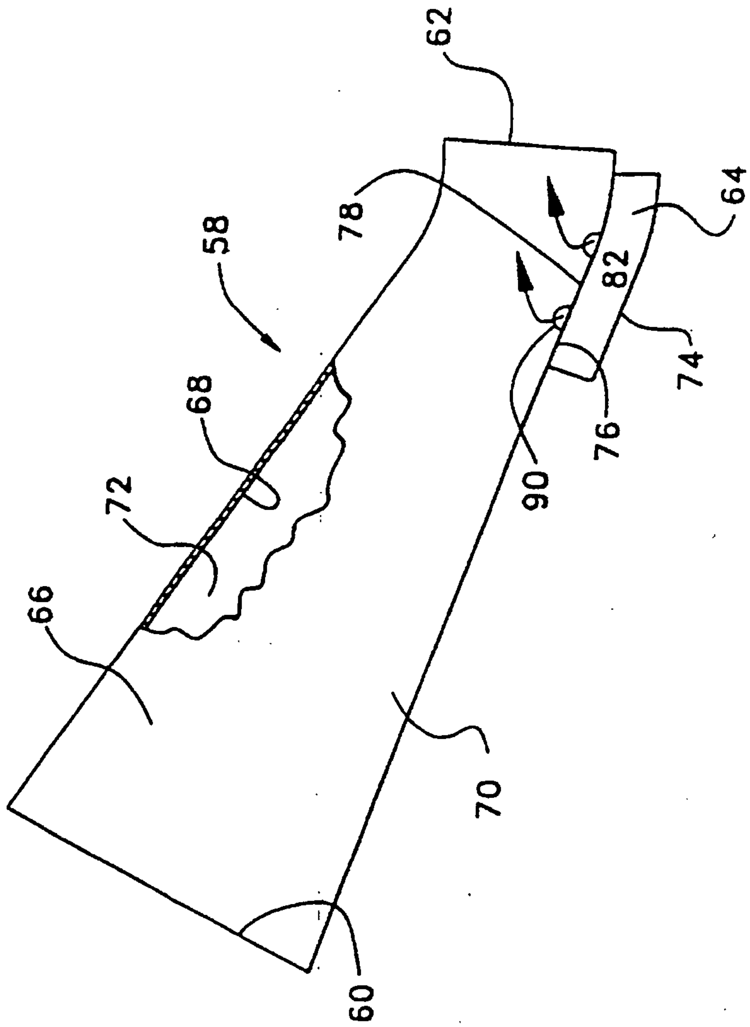

FIG. 5

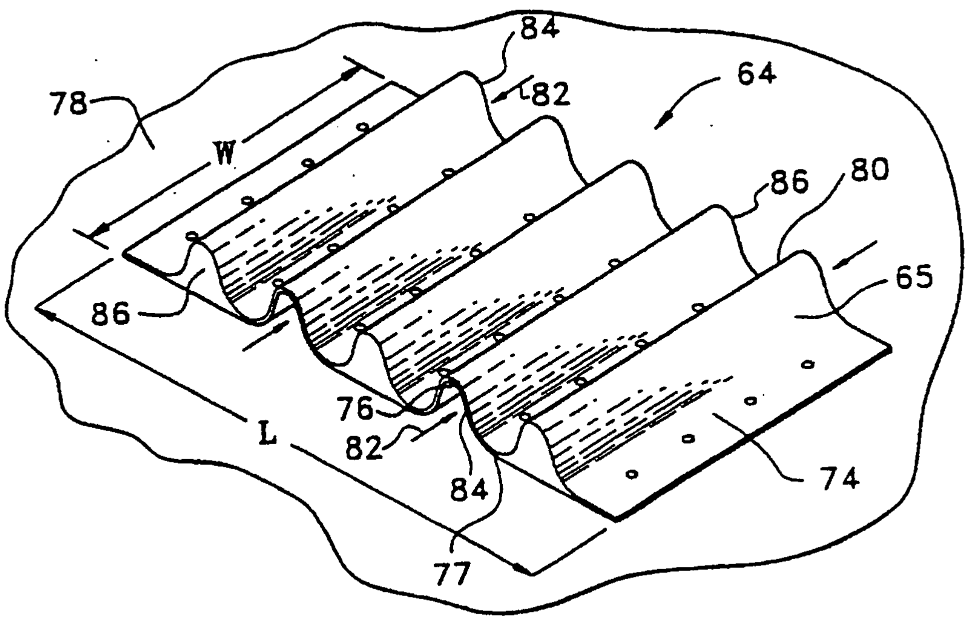

FIG. 6

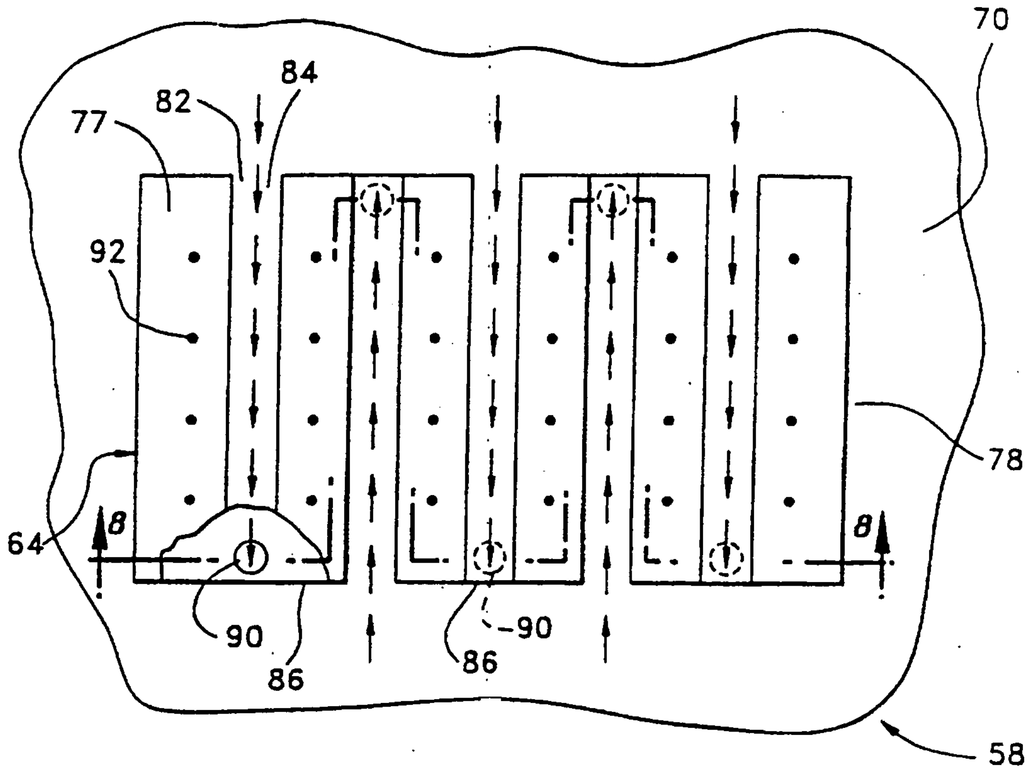

FIG. 7

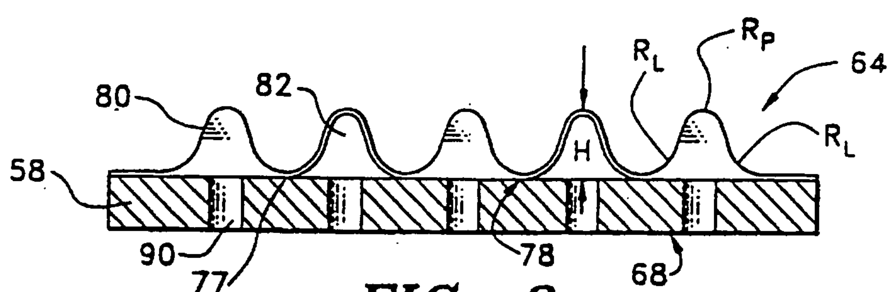

FIG. 8

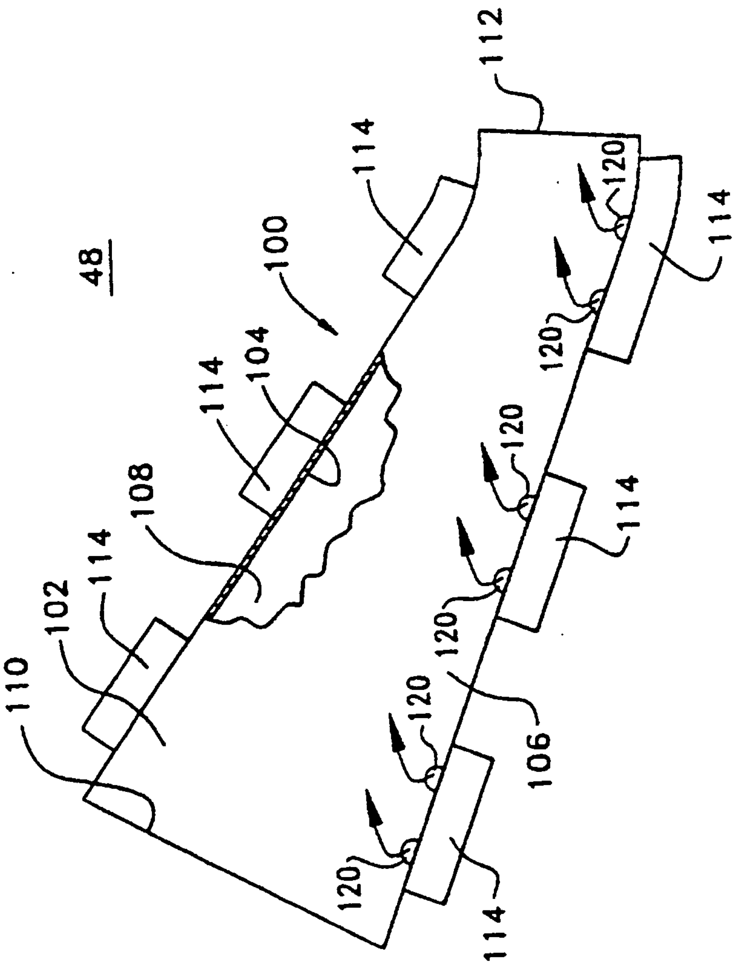
48
100
102
104
106
108
110
112
114
114
114
114
114
114
120
120
120
120
120
120
120

FIG. 9

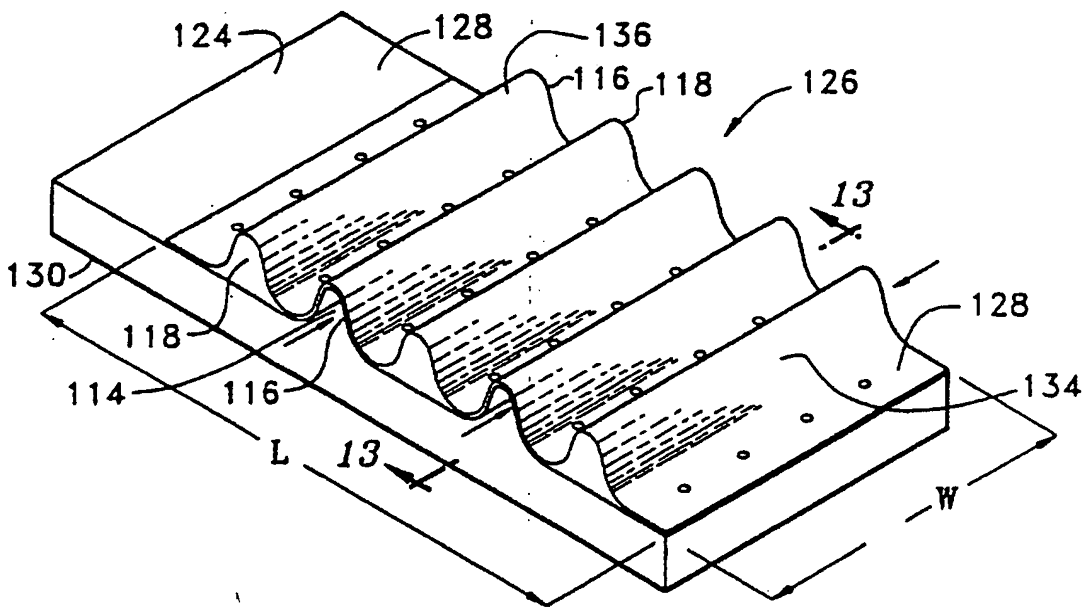

FIG. 10

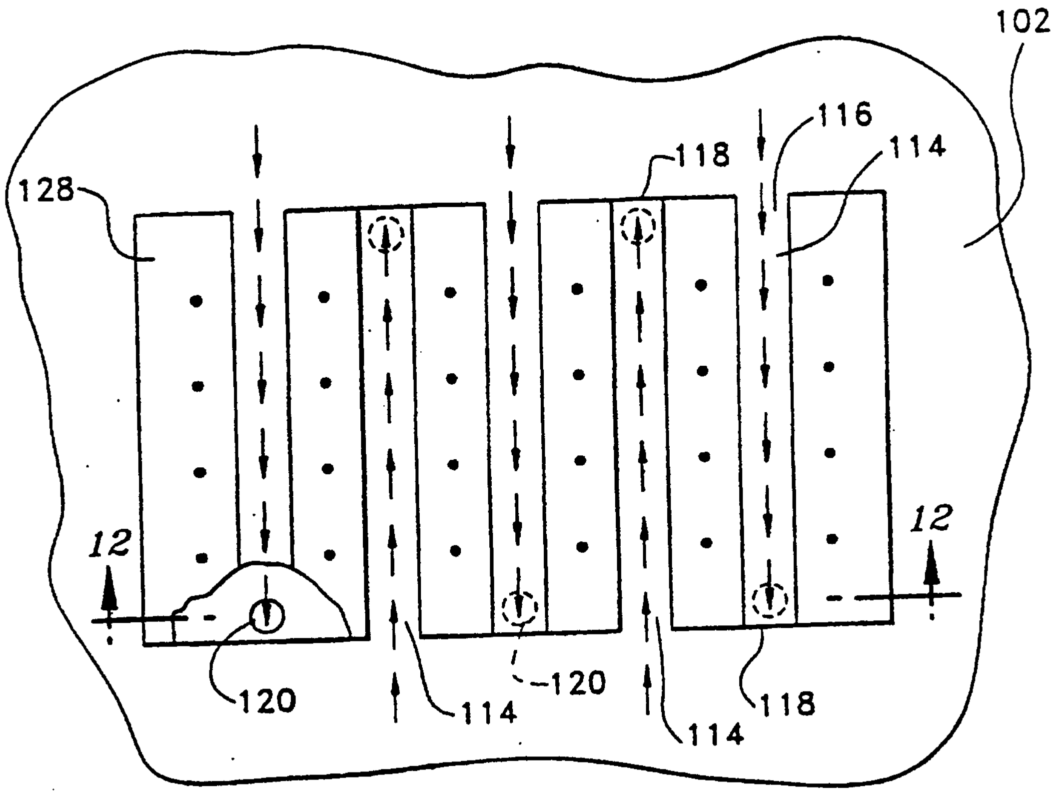
102
116
118
114
128
12
12
120
114
120
114
118

FIG. 11

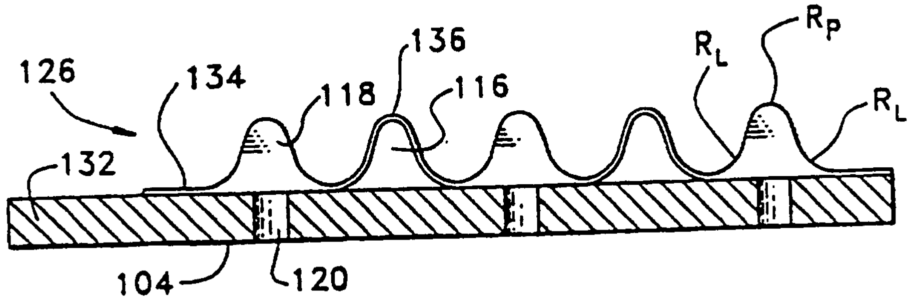
136
126
134
118
116
R_L
R_P
R_L
132
104
120

FIG. 12

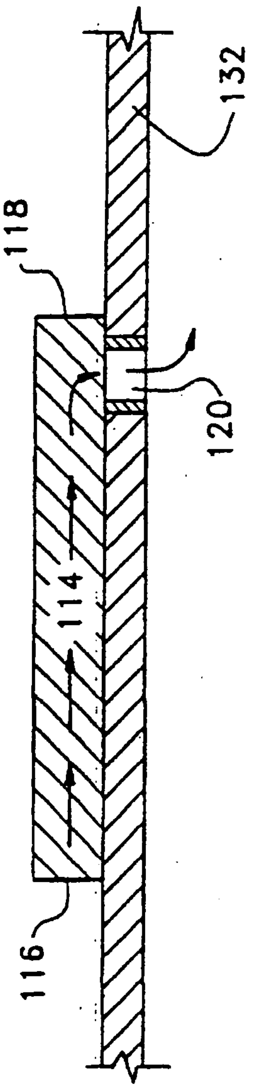

FIG. 13